The flood waters from the Little River began to pour into the Brazos just above Valley Junction on Saturday, September 10. The gage at Valley Junction showed a stage of 3.5 feet at 7 a. m. of that date. At 4.30 p. m. the river was up to 25 feet, rising fast, and at 6.30 p. m. bank full. The observer then warned all residents to leave. No gage readings were taken September 11, 12, and 13, but measurements made from marks left by the flood showed that the maximum height was 58.2 feet, only 0.8 foot below the record flood of December, 1913, but 4.2 feet higher than flood of the spring of 1915. The flooded area was approximately 4 miles wide. Cotton and corn were ruined, and railroad tracks and bridges washed out for a distance of 3 miles, suspending travel for six days. There were no deaths. Flood stage at Valley Junction is at 44 feet.

At Washington, near Navasota, the stream began to rise rapidly about 8 p. m. September 10. The initial 24-hour rise amounted to 21.8 feet to a stage of 27 feet at 7 a. m. September 11. During the next 24 hours there was an additional rise of 15.2 feet, and the stream ultimately reached the peak of the flood on the morning of September 14, with gage reading 50 feet. This was 5 feet above flood stage, but 2.9 feet below the flood of April, 1915. At this time the stream varied from 1 to 3 miles in width. The damage is estimated at $150,000. There was no loss of live stock.

At Hempstead a high-water gage only is maintained on account of the yielding nature of the banks. The maximum stage reported was 40.2 feet, 0.2 foot above flood stage at 7 a. m. September 16. This is 6.3 feet below the flood of April, 1915. The lowest section of the river gage was washed away with the initial rise. The damage from the flood is estimated at $43,500, including $1,000 for loss of live stock. The money value of property saved by warnings is estimated at $100,000. Wallis, Austin County, located below Hempstead, reports $5,000 damage to cotton and corn, and a saving of 1,500 head of cattle, valued at $37,500, through the warnings.

Flood stage was not attained at Rosenberg, although the stream was bank full to overflowing near the coast where the land is level and the run-off correspondingly slow. No damage occurred, except that the Freeport harbor entrance had shoaled as a result of the flood and had to be dredged to release a steamer.

Acknowledgment is made of the receipt of reports of damage furnished by county judges of Bastrop, Bell, Blanco, Burleson, Comal, Gonzales, Guadalupe, Hays, Lee, and Wilson Counties.

TABLE 1.—*Deaths and losses from September, 1921, floods, so far as reported.*

Counties.	Deaths.	Buildings, bridges, roads, etc.	Crops, corn and cotton.	Live stock.	Other damage.	Total losses.
Austin	0	0	$5,000	0	0	$5,000
Bastrop	0	$2,000	6,000	*	0	8,000
Bell	5	500,000	3,000,000	*	$200,000	3,700,000
Bexar	51	5,000,000	*	*	*	5,000,000
Blanco	0	0	2,000	0	0	2,000
Burleson	0	25,000	750,000	*	10,000	785,000
Comal	0	2,000	70,000	*	*	72,000
Fayette	0	*	15,000	$1,500	750	17,250
Gonzales	0	1,000	2,500	0	*	3,500
Grimes	0	*	150,000	*	*	150,000
Guadalupe	0	2,000	20,000	0	*	22,000
Hays	0	50,000	20,000	2,500	50,000	122,500
Milam	66	*	*	*	*	6,000,000
Travis	0	600,000	225,000	25,000	30,000	880,000
Waller	0	2,500	37,500	1,000	2,500	43,500
Williamson	93	*	*	*	*	2,205,000
Wilson	0	15,000	*	*	*	15,000
Total	215	6,199,500	4,303,000	30,000	293,250	19,030,750

* Included in total or other items.

TABLE 2.—*Money value of property saved by warnings, so far as reported.*

Austin County	$37,500
Fayette County	20,000
Waller County	100,000
	157,500

THE SAN ANTONIO FLOOD OF SEPTEMBER 10, 1921.

By J. H. JARBOE, Meteorologist.

[Weather Bureau, San Antonio, Tex., Sept. 23, 1921.]

On the morning of September 10, 1921, between the hours of 12:30 and 6:00 a. m. the most destructive flood in the history of this section swept through the city of San Antonio. Buildings, bridges, and streets gave way in the path of the flood and great damage resulted. An area, about 6 or 7 miles long and from one-half to 2 miles wide, including the business section, was inundated to the depth of from 2 to 12 feet. Three separate floods merged into one in the southern part of the city. Fifty-one lives are known to have been lost, and property damage was estimated at between four and five million dollars.

Rainfall in San Antonio.—A drought of two months' duration was broken when a shower of 0.53 inch fell between 6 and 7 a. m., September 8. Seventeen hours later, between 12:00 midnight and 1:00 a. m. on the 9th, steady rains began and continued until shortly after 11:00 p. m.—a period of about 23 hours. The crest of the flood came through the city two hours after the precipitation ended.

The amounts of precipitation, as measured at the United States Weather Bureau, are as follows:

	7:00 a. m.	7:00 p. m.	
Sept. 8	0.53 inches	0.01 inch.	
Sept. 9	3.48 inches	1.90 inches.	
Sept. 10	1.46 inches	T.	Total, 7.38 inches.

This shows a total amount of 6.84 inches for the 24 hours ending about 11:00 p. m., September 9th. If the showers that occurred on the morning of the 8th are included, the total is 7.38 inches.

Records of the rainfall at San Antonio since 1885 show that only on one occasion has the 24-hour amount of September 9, 1921, been equaled or exceeded. This occurred on October 1–2, 1913, when 7.08 inches in 24 hours were recorded, and a destructive flood followed.

At the Weather Bureau station, near the center of the city, 1.46 inches of rain fell between 7:00 p. m. and 11:00 p. m., September 9. However, the rainfall increased rapidly north and west of this point until amounts of 3, 4, and 5 inches occurred during this same period of time at stations located from 2 to 5 miles distant.

On a map of the San Antonio River and its tributaries, accompanying this report, Fig. 1, are located 12 stations at which measured amounts of rain preceding the flood are shown. At five of these stations the precipitation was measured in regular 8-inch gages. See table 2, p. 526. At the remaining stations, including 9 others just outside limits of the map, improvised gages such as cans, barrels, and in one instance a wooden trough, were used. Allowance was made for sloping sides and rounded bottoms where these occurred. With but one exception each of the 21 gages was visited, inspected, and the measurements carefully checked.

In this connection the cooperation of the Engineering Department of the United States Army is kindly acknowl-

edged. Without their aid this report could not have been so complete.

Reliability of rainfall measurements.—At seven stations using regular rain gages the measured amounts are considered very reliable. The observers in some instances have kept rainfall records for many years. The nine stations using improvised rain gages are given only approximate values in this report. However, the value of the data can not be based on the measurements of rain at any one locality, but on the large number of measurements taken over a relatively small area. The combined areas of the drainage basins responsible for this flood is approximately 75 square miles. In and adjacent to this drainage basin there were 12 measurements available and, with few exceptions, these measurements are in close accord. It is to be regretted that only at a few stations could amounts at different periods of the rain be obtained.

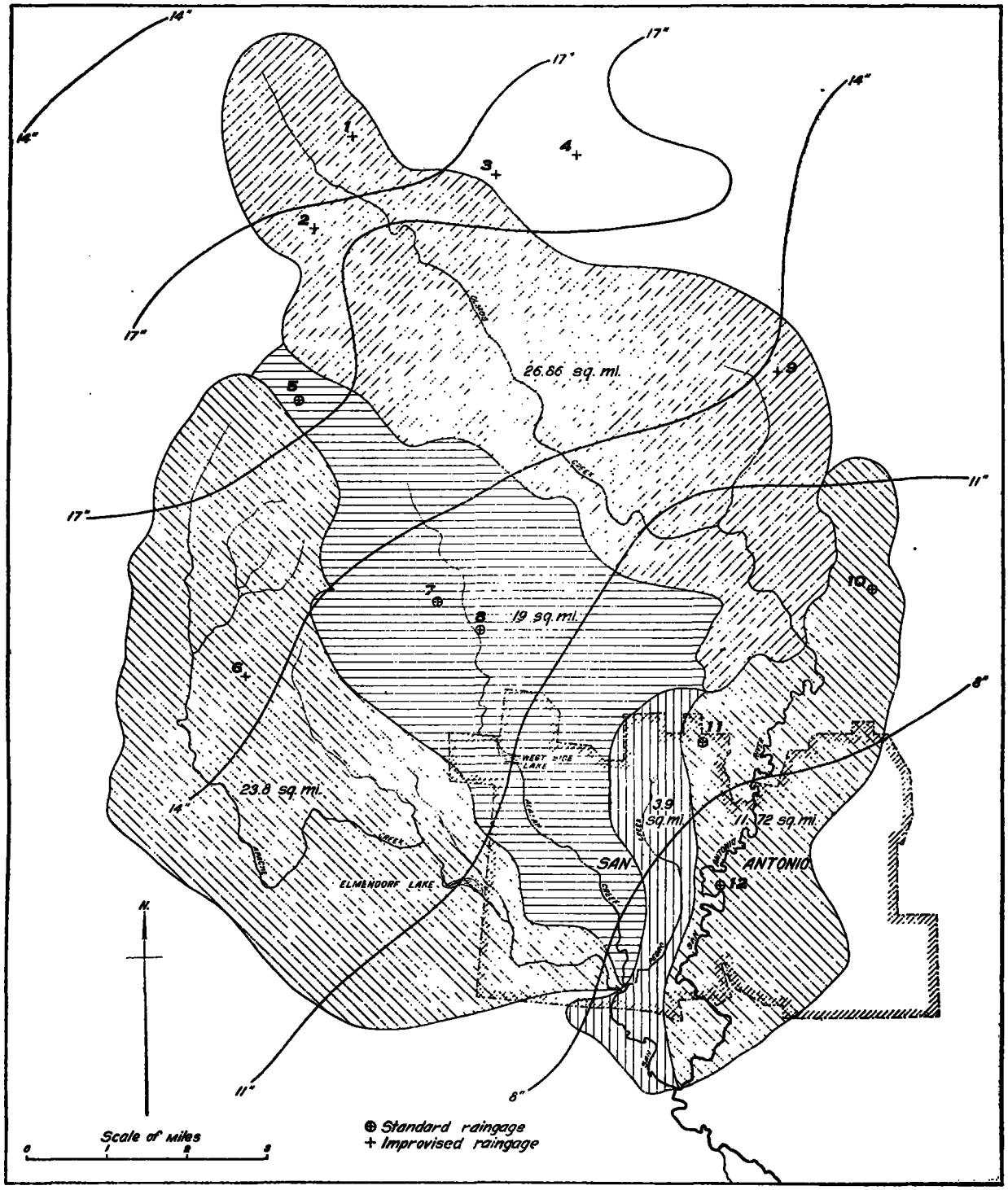

FIG. 1.—Drainage areas of the San Antonio River and its tributaries and the location of standard and improvised rain-gages. (See also Table 2, p. 526, this REVIEW.)

Heavy rains shown.—Study of the accompanying map shows the rapid increase of rainfall north and west of the Weather Bureau station. Two miles north, 9.50 inches were recorded, with 3 inches after 7:00 p. m. on the 9th, as compared to 1.46 inches at the Weather Bureau station. Further study of the map brings out the fact that

approximately three miles north and west from the city more than 10 inches must have fallen. Between five and six miles north and west from the city's center the rainfall undoubtedly reached 14 inches over a considerable portion of the drainage areas. Nine stations show 15 inches or more.

The heaviest rainfall probably occurred 8 to 10 miles northwest of San Antonio. Beyond this point the rainfall was not so heavy, as shown by the 8-inch gage located 17 miles northwest, where 10 inches were recorded.

It is possible, but hardly probable, that some section of these drainage basins received 20 inches of precipitation in the storm preceding the flood. Two stations show this amount, but much evidence would be necessary before those familiar with rainfall data could accept the figures.

Results of the run-off.—The Olmos, the largest of the three basins, extends back into the hills about 9 miles, so the flood crest on the Apache and Alazan, running from shorter watersheds, reached the city first. The crest on the Olmos came in time to merge with their waters.

The principal loss of life in the city was caused by the Alazan. From practically a dry bed, this stream rose with little warning. Several hundred houses, mostly small structures, were swept along on its waters, wrecked and piled against the railroad trestles below.

The Olmos caused the flood in the business section. This tributary of the San Antonio River carries virtually no water except during wet periods. Estimates show that around 30,000 second-feet moved through the Olmos basin at the peak of the flood. Preliminary figures show that 21,000 second-feet were moving across Houston Street at 1:00 a. m. on the morning of the 10th.

The water rose so rapidly that automobiles were deserted on the streets, and their occupants sought safety in high buildings. Five to nine feet of water stood in the large hotels, theaters, and stores. Great quantities of merchandise were injured, and in many instances swept into the river. The swift currents carried away miles of city pavements and injured or destroyed many bridges.

City water and power services were disabled and rescue work was handicapped by darkness. The loss of life undoubtedly would have been greater but for the proximity and efficient assistance rendered by the United States Army. Pontoons were brought in trucks from Camp Travis, and the Army Engineers quickly bridged the streets with their boats, giving timely aid to many people in precarious positions.

Previous floods.—Nine floods are known to have occurred in San Antonio prior to the flood of September 10, 1921. Lives have been lost and considerable property damage sustained, when varying amounts of water from 4,000 to 20,000 second-feet passed through the city. Careful estimates indicate that during the crest of the 1921 flood a flow around 30,000 second-feet must have been reached.

In the dust-laden archives of the old San Fernando Cathedral at San Antonio, Tex., are the records of a destructive flood which visited this section in 1819. The heights of the water on many old landmarks in and about the city are recorded. Engineers have estimated the discharge for this flood, and the figures do not fall far below those of September, 1921.

In 1845 there was another flood which caused considerable damage, and the city council decided to move the town, but public opinion did not favor this decision.

On March 16, 1865, another severe flood occurred. This flood was preceded by a terrific hailstorm, in which hailstones weighing 2½ pounds fell. Many mules, horses and small animals were killed. People were drowned on Commerce Street from the flood waters following this storm.

The flood of September 10, 1921, stands as the most destructive flood in the history of this valley. Realizing that the conditions previously given could happen again, plans are under consideration by the municipal authorities to prevent a reoccurrence of the catastrophe.

EXCESSIVE RAINFALL AND FLOOD AT TAYLOR, TEX.

By J. P. McAULIFFE, Observer.
[Weather Bureau, Taylor, Tex.]

There occurred at Taylor, Tex., and its vicinity during September 9–10, 1921, the greatest 24-hour rainfall on record for the United States, 23.11 inches, with 23.98 inches in 35 hours. During the night of the 9th–10th, ending with the 7:00 a. m. observation of the 10th, 19.49 inches of rain fell. The period of heaviest rainfall was from 6:45 p. m. to 9:42 p. m. of the 9th, when 10.50 inches were recorded. At this point the tipping bucket was flooded, stopping the automatic register. Rainfall was not so rapid after 10:00 p. m., and after midnight changed to intermittent showers, which continued until about 3:00 a. m. of the 10th, when the rate of fall again became excessive, the rain continuing as a steady downpour until 7:28 a. m., after which it fell at a moderate rate. The times of beginnings and endings of rain, and the total amounts are as follows:

	Inches.
September 9:	
Rain began about 3:30 a. m.	
Total, midnight to midnight	16.11[1]
September 10:	
Rain ended 2:30 p. m.	
Total midnight to midnight	7.87[1]
Total	23.98

Total duration, 35 hours.

[1] Partly estimated; tipping bucket stopped before midnight.

The most remarkable feature of this storm was its duration, covering a period of 35 hours, with an excessive rate over a period of more than 10 hours. Although continuous rainfall at an excessive rate ended shortly after midnight, it did not cease entirely, and from 12 midnight of the 9th to 3:00 a. m. of the 10th there were several showers at an excessive rate, with moderately heavy rain intervening. From 3:00 a. m. of the 10th until 7:28 a. m. rainfall fell at an excessive rate.

From about 9:00 p. m. of the 9th until midnight the streets of Taylor ran 4 feet deep in water at the maximum depth, with an average depth in all but the highest places of from 1 to 3 feet. This condition occurred again from 5:00 a. m. to 7:30 a. m. of the 10th. The waters washed up pavements, filled cellars and basements to overflowing, and carried away bridges, culverts, and houses. The basements of many buildings were filled with water to the ceilings, and it required the services of the city fire pumpers several days to pump the water out.

By 10:00 p. m. of the 9th the waters of Bull Branch had risen to unprecedented height, carrying away the home of J. W. Sillure, corner Porter and Eleventh Streets. The house lodged against a concrete bridge 300 feet east of its site, being practically a total wreck. The homes of B. A. Harcourt and Mrs. Dora Le Bleu, corner Wash-